THE GEOLOGY OF DUBBO.

By the Rev. J. Milne Curran, F.G.S.

(Plates 22 and 23.)

Introduction.—Dubbo is situated on the verge of the great alluvial which characterise the interior of New South Wales. A few miles to the north-west, we see, as it were for the last time, the older rocks before they are lost, as truly as if they dipped under the sea. The general aspect of the country is level. There are no mountains, and the few hills which diversify the otherwise almost uniform level are simply patches of basalt or of a very ferruginous conglomerate which have been able to resist the denuding influences better than the prevailing sandstones.

The average height above the sea of the country, immediately about Dubbo, may be taken at 900 feet. Although not situated exactly on the plains which extend hence towards the west and north-west, yet the same causes which have been at work to form those plains are very marked in their effects about Dubbo. In other words the present physical features of the country are due more to a filling up process than to the effects of denudation. The precipitous and rugged country about the Upper Macquarie, the chains of basalt capped hills in the Bathurst district, and all the surfaces which form the valley of the river down to Wellington have been carved into their present shapes by the subaërial influences of air, frost, rain and rivers. Near Dubbo we might draw the line which would show the limit of deposition, denudation and deposition being synchronous and co-equal. The basaltic hills referred to have their representatives at Dubbo, but with their summits barely on a level with the surrounding country.

Previous Observers.—Mr. Stutchbury, when in the employment of the New South Wales Government, visited the coal seams which crop out on the Talbragar River, about 28 miles north-east from the town. He considered the seams exposed as valueless, but believed them to represent some part of the great coal formation of the colony. In February, 1870, Prof. Thomson, when on a visit to Wellington district, examined some specimens (forwarded to him by Mr. James Samuels) which he labelled " Fossil Plants similar to some found in the coal measures at Talbragar."

Rev. W. B. Clarke, in the third edition of the "Sedimentary Formation," (1875) says he traced the Hawkesbury rocks at intervals all along the escarpments to the westward of Sydney from the latitude of the Clyde River to that of Talbragar.

Mr. G. S. Wilkinson, F.G.S., F.L.S., the present head of the Geological Survey, visited the Dubbo district in 1880. In his progress report for that year he says " Immediately about Dubbo the formation consists of the Hawkesbury formation, covered in places with basalt and auriferous tertiary gravels, but on the Talbragar River, about 12 miles north-east of Dubbo, the Hawkesbury rocks are seen over-lying the coal measures, containing seams of inferior coal; there is little doubt therefore but that the coal measures will be found underlying the Hawkesbury rocks in the vicinity of Dubbo, but at what depth can only be ascertained by boring or sinking."

Mr. E. F. Pittman, who examined the same localities, in company with Mr. Wilkinson, says (Annual Report Department of Mines, New South Wales, 1880, p. 243) "From Dubbo the road via Cobborah to the Castlereagh lies over the Hawkesbury sandstone, with overlying Pleistocene drift and patches of basalt.'

"About Heane's Station there are outcrops of what appears to be the true coal measures. These are well seen in section with small seams of poor coal at Ballimore on the Talbragar about 6 miles from Mr. Heane's, though I could find no fossils except some faint impressions of plant stems.

" South of Dubbo the Hawkesbury sandstone extends for about 10 miles (with occasional cappings of basalt) and then gives place to rocks of Silurian age."

"The country between Dubbo and the Castlereagh appears to be formed of a coal basin, the centre of which is situated a few miles north of Dubbo, and it is quite probable that the thin seams of coal seen in the cliff at Ballimore may overlie others of a payable character."

In February 1883 the Rev. J. E. Tenison-Woods describes some fossils from this district. [L. S., N.S.W.] This with my own short paper (read on the 26th March) seems to be all at present known of the Geology of Dubbo.

Distribution of Rocks.—Sandstone is the prevailing formation. It is not known exactly how far it extends towards the north-east. Due east from Dubbo it extends about 30 miles and then gives place to Silurian limestones and slates. The sandstones differ very much in texture and composition in different localities. Generally it is hard and durable when it lies under, or is in close proximity to basalt. At Barbigal and at Troy a quartzite with a scarcely perceptible granular structure is developed in this way, while in many other place it is so friable as to weather into a shapeless mass after a few months exposure.

When exposed along creeks or in cuttings it presents all the peculiar characteristics of the Hawkesbury sandstone. The faces of the rocks are excavated by atmospheric influences and the rending effects of crystallising salts, into caves and hollows; the false bedding, peculiar ironstone bands, and concretions, are strongly suggestive of the sandstones on the eastern slopes of the mountains.

Conglomerates are met with at various levels in the series but never preserving their character over any considerable area. The shingle of an old water-course is exposed on the Talbragar near Murrungundy. The deposition and "lie" of the shingle show—if a solitary instance is of any value—the drainage to have been in the same direction as in the existing river system. A thick bed of conglomerate caps the hills over the coal at Ballimore.

Surface indications of conglomerates are apt to mislead casual observers in the country about Dubbo. In travelling over the country known as Ironbark Ridges the formation seems to consist of very thick beds of conglomerates. It is visible in the valleys and on the hill tops—quartz and felspar pebbles cemented by a ferruginous paste. On sinking it is found to be a comparatively thin layer on the surface. The explanation is that the pebbles are probably all that remain there of many hundred feet of rock through which they were distributed. The cementing is an altogether subsequent work.

It was reported that a thick bed or beds of conglomerate was cut through in the diamond drill bore put down near Dubbo by the Railway Department, but from an examination of the cores, I can say that the conglomerate so called barely merits to be described as a pebbly sandstone. True conglomerate is an exceptional formation in the District.

Between the Brick Yards platform and Murrumbidgeree Station the Palaeozoic rocks disappear and the first section of the sandstone is seen.

This is the extreme edge of the basin, for limestone crops out in a creek a few yards to the north of the railway fence. From this the sandstones and shales continue, with occasional patches of basalt, until granite is met at 289-10 miles. Throughout this distance every visible section shows wavy beds forming small basins without any appreciable general dip. Nowhere is the dip greater than 5°.

Before meeting the granite at 289 miles a remarkable instance of metamorphism may be seen. A ferruginous rock with irregular concretions or rather patches of darker colour, contains water worn pebbles. A few chains further it grows more compact and a crystalline structure is gradually developed. Further on it might be called a Binary Granite with flesh coloured felspar.

Beyond this again the sandstone and ferruginous grits appear, then granite continues for about six miles.

About 293-60 miles an exceptional condition presents itself. Instead of the usual friable and horizontal beds, the rocks, compact and slaty and not unlike some upper Silurian and Devonian beds in other parts of the Colony, are inclined at an angle varying from 58° to 63° dipping to the north-west. This is the only instance of the kind in the district. It is not impossible that they might represent the older rocks appearing again at this the other extremity of the basin. I could find no fossils. A more probable opinion is that they are part of the Dubbo series, tilted to their present position by an outburst of basalt. The nearest visible rock is granite, but for many reasons it is impossible to think the granite of later origin than the sandstones. The inclined rocks form an isolated hill, a fact which increases the difficulty of determining either their relative age or the cause of the disturbance. An additional interest is attached to these beds from the fact that they dip under the great plains at this point.

Basalt covers about one tenth of the area of the country immediately around Dubbo. The isolated patches on the right bank of the river are part of one great stream that flowed down the old river valley. The basalt on the left bank of the Macquarie seems to be an older flow. A wall of vesicular basalt 40 feet in height may be seen on the Mogrigui Creek.

On Gearie Station near Murrumbidgeree there is an isolated conical hill, which is I have no doubt an old volcanic "neck," It is very different from the usual table-topped basalt-crowned hills that may be seen from its summit, and which are the remains of a great basaltic plateau.

A peculiar appearance is often presented when the surface of the basalt is weathered into a gentle slope. The surface of the ground resembles a ploughed field. The ridges are always parallel but often curved at sharp angles, though still preserving their parallelism. The average height of the ridges is about five inches or less from crest to trough, and they vary in width from six to eighteen inches. No satisfactory explanation as to the cause has yet been given. I would suggest that the appearance is connected with the jointings of the basalt below. The furrows do not always follow the incline on the surface, so they cannot be due to the effect of *running water*. We must only suppose that joints in the basalt are being filled with clays from the surface by rain waters as they filter through, and that every furrow marks the position of a joint in the cooled lava stream.

Division of the Strata.—Although surface indications would lead to the belief that all the rocks about Dubbo should be referred to the same age, we have ample evidence to enable us to distinguish two formations—the Dubbo sandstones and the Ballimore coal basin.

The diamond drill boring put down near the town of Dubbo showed the following section. A section I measured at Ballimore gives the following succession :—

	′	″
Grit	25	0
Ironstone	0	6
White shale and ferruginous sandstone ...	18	0
Ironstone	1	0
Impure fireclay	3	6
Ironstone	0	6
Fireclay	3	2
Ironstone band	1	6
Impure fireclay	6	0
Irregular ironstone bands ... . } ferruginous sandstones and shales ... ... }	14	0
White fireclay	1	3
Talus	20	0

The fossils are equally distinct.

Fossils from Dubbo.

Thinnfeldia odontopteroides.
media.
Odontopteris macrophylla.
Alethopteris australis.
Hymenophyllites, sp.
Walchia, sp.

FOSSILS FROM BALLIMORE.

Sphenopteris crebra.
glossophylla.
Neuropteris australis.
Alethopteris currani.
concinna.
Merianopteris major.
Walchia milneana.

In correlating these formations with others we have to depend altogether on the fossils. To facilitate comparison I have compiled the table (A) appended, which shows at a glance what fossils are common to any two localities, where our Mesozoic rocks are developed. Authority or reference is given for every species enumerated. Dr. Feistmantel's larger work is so inaccessible to students outside Sydney, that I refer to his paper in the volume of our Royal Society for the year 1880.

TABLE A.

—	Alethopteris australis.	Alethopteris concinna.	Alethopteris currani.	Thinnfeldia odontopteroides.	Thinnfeldia media.	Phyllotheca concinna.	Phyllotheca, sp.	Phyllotheca australis.	Sphenopteris elongata.	Sphenopteris crebra.	Sphenopteris glossophylla.	Sphenopteris, sp.	Odontopteris microphylla.	Odontopteris macrophylla.	Odontopteris, sp.	Merianopteris Major.	Taeniopteris daintreei.	Macrotænopteris wianamattæ.	Pecopteris tenuifolia.	Gleichenia dubia.	Gleichenia, sp.	Podozamites distans.	Podozamites, sp.	Zeugophyllites.	Walchia Milneana.	Walchia, sp.
Wianamatta ...	25 +	...	...	11 +	...	28 +	...	...	...	...	...	15 +	12 +	...	...	...	...	14 +	13 +	34 +	31 +	29 +	30 +	...	...	...
Hawkesbury ...	18 +	...	...	19 +	...	35 +	21 +	8 +	...	...	...	10 +	...	...	9 +	...	...	24 +	...	23 ...	...	22 +	...	...	...	...
Dubbo	26 +	...	...	41 +	27 +	...	...	...	...	...	...	...	...	32 +	...	...	...	...	...	...	...	...	...	...	...	...
Ballimore	...	37 +	38 +	...	...	...	...	...	...	42 +	43 +	...	...	...	...	39 +	...	...	...	...	...	...	...	...	44 +	...
Clarence	5 +	...	...	6 +	...	...	...	...	...	...	...	17 +	...	...	...	...	4 +	...	...	...	...	...	...	33 +	...	48 +
Ipswich	36 +	...	...	47 +	...	45 +	...	...	3 +	...	...	...	...	...	...	...	46 +	40 +	...	...	...	...	...	...	...	...

The figures refer to the notes on the following pages.

Notes to Table A.

1, 2, 3. Tenison-Woods, Lin. Soc., N.S.W., Vol. VIII., p. 107.

4. Wilkinson. Notes on Geol., N.S.W., p. 55, and in Annual Rep. Dep. Mines, 1880, p. 239. Pittman. Rep. Dep. Mines, 1880, p. 244. Feistmantel, Proc. Royal Soc., N.S.W., 1880.

5. Same refs. as 4. Also Tenison-Woods, Lin. Soc., N.S.W., Vol. VIII., pp. 54-112.

6. Refs. as 4.

8. Notes Geol., N.S.W., p. 54.

9, 10. Ditto, and Feistmantel, Proc. Royal Soc., N.S.W., 1880.

11. Notes on Geol., N.S.W., p. 54. Tenison-Woods. Royal Soc., N.S.W., 1883, p. 82.

12, 13. Notes on Geol., N.S.W., p. 54. Feistmantel. Royal Soc., 1880.

14. Ditto, and Tenison-Woods. Proc. Royal Soc., 1883, p. 82.

15. Wilkinson. Notes on Geol., N.S.W., p. 54.

17. Pittmann. Ann. Rep. Dep. Mines, 1880, p. 244.

18. Tenison-Woods. Royal Soc., N.S.W., 1883, p. 82.

19. Tenison-Woods. Royal Soc., 1883, p. 82. Feistmantel. Royal Soc., 1880.

21. Tenison-Woods. Lin. Soc., Vol. VIII., p. 74. Royal Soc., N.S.W., 1883, p. 82.

22. Royal Soc., 1883, p. 82.

23, 24, 25. Ditto ditto.

26. Lin. Soc., N.S.W., Vol. IX., p. 251.

27, 28, 29, 30, 31. Tenison-Woods. Lin. Soc., N.S.W., Vol. VIII., p. 103. Royal Soc., 1883, p. 82.

32. Lin. Soc., N.S.W., Vol. IX., p. 250.

33. Ann. Rep. Dept. Mines, 1880, p. 239.

34. Feistmantel. Royal Soc., 1880.

35. Tenison-Woods. Lin. Soc., N.S.W., Vol. VIII., p. 75.

36. Refs. as 35, pp. 54-112.

37. Lin. Soc., N.S.W., Vol. VIII., p. 112.

38. Lin. Soc., N.S.W., Vol. VIII., p. 113.

39. Lin. Soc., N.S.W., Vol. VIII., p. 114.

40. Lin. Soc., N.S.W., Vol. VIII., p. 118.

41. Tenison-Woods. Lin. Soc., N.S.W., Vol. VIII., p. 106. Royal Soc., N.S.W., 1883, p. 82.

43. Lin. Soc., N.S.W., Vol. VIII., p. 94.

44. Lin. Soc., N.S.W., Vol. VIII., p. 163.

45, 46. Lin. Soc., N.S.W., Vol. VIII., p. 54.

47. Lin. Soc., N.S.W., Vol. VIII., p. 105, and Carruther's Qutly. Jour. Geol. Soc., Vol. XXVIII., p. 355.

48. Mines and Mineral Stat., 1875, p. 178. (In later editions Mr. Clarke substitutes name Voltzia.)

Age of Formations.—Although lithological resemblances are not always a safe guide in identifying widely separated formations, yet, before any fossils were found, the general opinion was that the Hawkesbury and Dubbo sandstones were of the same age. Fossils have since been discovered which confirm that opinion. The age of the Ballimore coal beds is not so easily determined. As may be seen from table A, Dubbo and Ballimore have not one fossil plant common to the two places. A comparison with Newcastle or Bowenfels is out of the question. No trace of Glossopteris is known from Ballimore. But the general aspect of the Ballimore fossils would lead me to think that Ballimore is a connecting link between the Upper Coal and the Hawkesbury rocks, that is, if the Clarence River beds are really newer than Hawkesbury sandstone.

The following fossils are recorded from the Clarence :—*Alethopteris australis*, *Thinnfeldia odontopteroides*, *Sphenopteris*, *sp.* *Tæniopteris Daintreei*, *Zeugophyllites*, *Walchia.* If we except Tæniopteris they differ in no way from the Hawkesbury fossils. It is not easy to see why the former are considered as of Jurassic and the latter of Triassic age. The table appended (B) shows how the formations referred to in this paper are correlated by living geologists. Hector's views are taken from an article by him in the Geological Mag., Jan. 1882, p. 28. The figures account for the others. It should be remarked that when mention is made of the lower carboniferous at Cowra, the country near that town generally is not to be understood, but only a well-defined belt running north and south, which is well seen on the Grenfel road five miles from Cowra.

TABLE B.

	Wilkinson.	Hector.	Tenison-Woods.
Jurassic			
upper / middle / lower	Clarence (9)	Clarence, Jerusalem Coal. T., Cape Patterson, V.	Hawkesbury & Clarence & Ipswich (1)
oolite			Ballimore, Burnett (2)
lias			
Triassic	Hawkesbury & Wianamatta (4)	Wianamatta	Newcastle Bowenfels (3)
Permian			
upper	Newcastle & Illawarra (8)	Hawkesbury	Greta, Anvil & Stoney Creeks (4)
lower		Newcastle, Stoney Creek & Wollongong	
Carboniferous			
upper	Greta and Anvil Creeks, West Maitland (7)		
lower	Cowra, Canowindra (6)	Port Stephens	Stroud, Manning, Cowra, Canowindra (5)

NOTES TO (B) TABLE.

1. Lin. Soc., N.S.W., Vol. VIII., p. 54-55. Royal Soc., N.S.W., 1883, p. 82.

2. Lin. Soc., N.S.W., p. 53.

3. p. 52.

4. Notes on Geol. N.S.W., p. 53.

5-6. Lin. Soc., N.S.W., Vol. VIII., p. 52.

6-7. Notes on Geol. N.S.W., p. 44.

8. p. 51.

9. p. 55.

Prof. Stephens (Lin. Soc. N. S. Wales, Vol. VIII., p. 527) has reason for thinking that some beds at the Clarence River are of more recent date than are usually supposed. He mentions fossil trunks resembling pines and leaves not unlike some of the *Pandaneæ* and a shell belonging to the *Unionidæ*. The presence of a species of *Unio* could hardly prove anything as to the age of the beds, for the family has a long range in time. The *Pandaneæ* date from Jurassic times, and it will be remembered that *Thinnfeldia* was probably a conifer. It is only fair to state that Prof. Stephens did not mention the fossils in support of the age. He merely recorded their presence.

So far, no two geologists are agreed as to the age of the Hawkesbury sandstone. But all are agreed as to the sequence of the Mesozoic formations, as follows:—Newcastle, Hawkesbury and Wianamatta, and Clarence River. Until I discovered the Ballimore fossils, (which were at once described by the Rev. J. E. Tenison-Woods) I was of opinion that the sequence just named was the true one. Now, I can see no reason for separating the Hawkesbury and Clarence by any great interval, and more, I think the Clarence is the older of the two. The Ballimore coal field with its own marked flora, I take to be older than either. In my opinion this represents the true successions of our Mesozoic rocks, proceeding downwards.

1. Hawkesbury and Wianamatta—
   With *Alethopteris australis*, *Thinnfeldia odontopteroides*, *Phyllotheca concinna*, *Macrotæniopteris Wianamattæ*, *Podozamites distans.*

2. Clarence—
   With *Alethopteris australis*, *Thinnfeldia odontopteroides*, *Sphenopteris* sp., *Tæniopteris Daintreei*, *Zeugophyllites* and *Walchia.*

3. Ballimore—
   With *Alethopteris concinna*, *A. currani*, *Sphenopteris crebra*, *S. glossophylla*, *Merianopteris major*, *Walchia milneana.*

4. Glossopteris Beds, Upper Coal Measures—
With *Glossopteris*, *Vertebraria*, *Gangamopteris*.

Origin of the Dubbo Sandstone.—Having now described the various appearances and the physical characteristics of the sandstones, we may proceed to enquire if any light can be thrown on their origin. Mr. A. G. Green remarks in his Physical Geology that if accumulations of blown sand be preserved it might be difficult to distinguished them from sandstones formed beneath water, unless they happened to contain land shells or land plants in the position in which they grew. In one respect however, they do differ. The grains are usually far more clearly rounded in blown sand than in subaqueous sandstones. I may state at once that the generally received opinion is that the Dubbo sandstones are like in origin to the sandstones about Sydney—fresh water or estuarine. I have given some attention to the matter, and excepting the fact that the stratification and false bedding are not unlike the stratification and false bedding exhibited in well known subaqueous rocks, there is no evidence whatever to offer in support of such an origin.

Fossils are plentiful enough, but they are *all* land plants. They are in such a wonderful state of preservation and so perfect (as the members will remember from specimens exhibited at a former meeting) that they could not have been drifted from any distance —they must have grown where we find them. The thin seams of coal represent old land surfaces. No fresh water or marine fossil has ever been discovered. As far as the evidence goes, we are only justified in considering the formation as *Terrestrial* in its origin.

The views, and the arguments by which they are supported, of the Rev. J. C. Tenison-Woods are too well known to require more than a reference here, but I may state that, as far as my observations go, no difficulties more weighty than those already urged will be furnished by the Dubbo rocks. It has been suggested in Mr. Tenison-Wood's paper that were it not for internal metamorphism the appearance of the sand grains would afford a clue to the origin of the sandstones. Daubrée, Sorby and Phillips all agree that blown sand, by its rounded and abraded particles can be distinguished from river-borne and other subaqueous sands. In the case of the Hawkesbury sandstone the once abraded and rounded grains may have been subjected to such conditions as would induce subsequent crystallisation. But we are aware of no means by which angular or crystalline particles could become rounded after deposition. A few rounded and abraded grains, even when the great mass of the rock is crystallised, would, to my mind, go far to uphold the Æolian theory, more especially when considered in the light of other facts equally significant. Rounded and abraded grains are to be found in the Dubbo sandstones. The slide I exhibit is a fairly typical one. The sand grains were well washed and spread on paper previously brushed over with gum. Portions containing seemingly abraded particles were then cut from the sheet.

Mr. J. Milne, in his notes on the Sinaitic Peninsula (Q. J. G. Soc., Vol. XXXI., p. 18.) mentions the definite character which blown sand gives the scattered stones in the desert about Nackhl. All have a peculiar polish, looking as if they had been smeared with grease, a lustre nearly represented in the fractured surface of some specimens of witherite. Should these stones, he remarks, become buried, future investigators will find in them marks as clearly indicative of their origin as the rounded forms of water-worn pebbles or the angular and scratched faces in beds of glacial drift. Just as we infer from the latter, the existence of former glaciers, so they will infer the former presence of deserts and "sand-drifts." The pebbles in the Dubbo sandstones, when cleared of the minute particles (quartz or decomposed felspar) adhering to the surface, have in very many instances that I have noticed, an appearance that rolling in water could never give them. But whether these may not be water-worn grains chemically corroded on the surface I am not prepared to say.

Another point worth considering is the great difference between the normal sandstone and those portions of it, which have undoubtedly been deposited in water. We often see beds of shale which split up into thin laminæ. This fissile structure is due to plates of mica which are visible on the fresh surfaces. Wind could not induce such a structure, unless the sand and mica were drifted into quiet water. This is exceptional, and very different from the greater part of the rock, where the mica is uniformly and sparsely distributed throughout the mass.

Richthofen describes a wind blown deposit (unstratified) in China, more than 1500 feet in thickness. He refers this to an origin wholly æolian, and calls it by the name of land-lœss, to distinguish it from like deposits in which water has co-operated. The latter he calls *lake-lœss.* I consider the sandstones at Dubbo to be a lake-lœss formation. Further research may find material for another view, but with the materials in hand it would hardly be justifiable to come to any other conclusion.

I may here observe that in the discussion on Mr. Tenison-Wood's paper, mention was made of recognising hyalite in thin slices of the rock. I have succeeded in preparing a few sections, which I now exhibit. The cohesion between the particles is, as a rule, so slight, that sections cannot be prepared except where metamorphism has more than ordinarily affected the rock. Unfortunately these sections give us no idea of the original structure. In the sections I lay before you the partly formed crystals as are close as the constituents of a ternary granite.

Origin of the Ironstones.—Beds of Ironstone are found at various levels in the series, but not to any considerable extent, except on the Talbragar River up and down from Ballimore. At the last named place (*vide* section above) it occurs in beds and lenticular masses, which leave no doubt as to its origin. It would be hard to find a better example than Ballimore, to illustrate the process so clearly put by Dr. S. Hunt in his "Origin of Metalliferous Deposits" (Chem. and Geol. Essays, p. 228). Every bed of ironstone marks an old surface as surely as every coal bed does. The bands of ironstone, never more than a few feet thick, represent shallow "lagoons" which held ferruginous water, derived from the surrounding rocks, through the agency of decaying organic matter. It might be said that every bed of iron represents a bed of coal.

Nodules of ironstone are found in the river drifts. When broken they exhibit a banded structure following the contours of the exterior—due to the change at various intervals of the ferrous carbonate into limonite.

Economic Geology.—About four years ago a sudden fresh removed a considerable amount of sand from the bed of Spicer's Creek near the point where the main road from Wellington crosses that creek. The *surface* of a bed of coal was in this way laid bare. A rude opening such as means at hand would allow, was made and I measured a seam thirty-seven inches in thickness, without going through the coal. Since then a seam 49 inches has been measured near the same place—probably the same coal. It has never been worked. Nearer to Dubbo, at Ballimore, several shafts have been put down, but although coal has been met with in every instance, the seams were thin. The quality of the coal has not been found fault with. It is bituminous and burns to a soft grey ash. The proportion of fixed carbon is small and as the coal does not cake it does not produce a true coke. An analysis, it is said, gave the following result:—

Water...	6·5
Vol. Hydrocarbons	45·4
Fixed Carbon...	37·6
Ash	10·5

It makes a good household coal and is no doubt suitable for stationary engines, but it would be less satisfactory in the case of locomotives. It easily breaks into small cubical fragments, which would be blown by the powerful blast through the boiler tubes. Efforts have been made in other localities to get payable coal, but the work has been undertaken in a most arbitrary manner, without theoretical or practical knowledge of coal mining. A slight acquaintance with the geology of the district would in most instances have saved a useless expenditure of money. There is every reason to believe that payable coal will yet be found. The physical features of the district are eminently favourable to the miner, as the rocks are not disturbed to a great extent. Trap is not so plentiful as to materially affect the coal, so that there will be few or no difficulties to contend with.

The outcrop of the coal on Spicer's Creek is near the edge of the coal "basin." A series of borings from this point following the dip of the beds would be the most effective method of proving that portion of the country.

Fireclay.—Thick beds of fireclay underlie the coal and ironstones at Ballimore. It is true that some specimens, sent to experts, were considered hardly suitable for the manufacture of fire-bricks. But it has been remarked that though chemical and mineralogical examination will often enable us to say that certain clays will assuredly not make fire-bricks; and that other clays are promising enough to make it worth while trying them; yet nothing short of making a test brick will settle the question. No bricks have been made as yet.

Freestone.—The sandstone is quarried in a few places for building stone. The best procurable is more friable and less ferruginous than Pyrmont stone, nor will it bear an equal weight. In fact the normal sandstone is hardly more than a mixture of quartz grains, decomposed felspar and mica, without any chemical union. In the proximity of basalt it is altered and more compact, and often changed into a quartzite, as at Barbigal and Dalton's Paddock, near the general cemetery. From some experiments I made with the building stone, I found that blocks of a cubic inch placed in water to a fourth of their depth, absorbed more than one-half of their own volume of water. Cubes repeatedly saturated with a solution of common salt lose their angles, and when treated in the same way with sulphate of soda rapidly disintegrate. The altered sandstones already referred to as quartzite, make a building stone durable as granite.

Granite.—It is well exposed on the the railway at 289·10 miles. It is a ternary granite, hornblende replacing the mica to a great extent. It takes a fine polish, having a slightly bluish tinge. Nothing shows how compact the crystals are better than the quality it possesses of holding together when reduced to thin slices for microscopic examination. In the near future it will be used for building purposes, as it is unquestionably the most durable stone about Dubbo. The rock as seen in the railway cuttings is traversed by numerous joints, that will facilitate the working.

Basalt.—The Dolerite about Dubbo is not sufficiently exposed to encourage its being sought as a building stone. For road purposes there is practically an unlimited supply within the circuit of a mile from the town.

Gold.—Gold has been worked, but in every instance outside the limits of the sandstone rocks, except when, as it often happens, the older rocks drain across them. Auriferous quartz reefs have been worked at Tomingly to the south west.

Iron.—The only source of iron known is the clay iron stone already described. It is best seen along the valley of the Talbragar. Taken with the coal and limestone, which is within easy reach, it may prove valuable.

Copper, galena, diamonds (from the gravel in old river beds), topaz and opal have been met with, but not in quantities of any "economic" value.

The microscopic character of the granites and basalts is reserved for another and concluding paper on the Geology of Dubbo.

NOTES AND EXHIBITS.

Mr. Macleay exhibited in illustration of his Paper on the Genus *Lamprima*, all the known species of the genus, excepting *L. Krefftii*, the type of which is in the Australian Museum. Mr. French's beautiful species *L. Muelleri* excited much attention.

Dr. von Lendenfeld exhibited a Syphonophore of the Genus *Diphyes*, found at Bondi by Mr. Whitelegge.

Mr. Masters exhibited well mounted specimens of two very rare Australian Butterflies, *Xenica Kershawi* from Victoria, and *Heteronympha Digglesi* from Five Dock, near Sydney.